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# Social Behavior, Organization and Leadership in a Small Flock of Domestic Sheep

J. P. SCOTT

*Department of Zoology, Wabash College, Crawfordsville, Indiana*

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# SOCIAL BEHAVIOR, ORGANIZATION AND LEADERSHIP IN A SMALL FLOCK OF DOMESTIC SHEEP[1]

J. P. SCOTT

*Department of Zoology, Wabash College, Crawfordsville, Indiana*

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## INTRODUCTION

The need for more scientific research on social problems is obvious. The lives of Americans have been dominated for the past fifteen years by war and economic disaster, and for many Europeans the period of failure and destruction has lasted twice that time. We need to understand and intelligently control social organization, and one of the ways in which this can be done is by the establishment of sound scientific generalizations based on repeated experiments and observation. In order to put these on the broadest possible basis we must analyze and classify the organization found in various sorts of animal societies.

That social behavior determines social organization appears to be a fundamental theory of general sociology. The author has obtained positive results from an experimental test of this theory as applied to a somewhat artificial type of organization in an inbred strain of the house mouse (16). In the study described below, a general analysis based on the same theory was attempted on an animal which has a wider range of social behavior, is capable of being raised under more natural conditions, and shows somewhat more resemblance to man. The results give further support to the theory and suggest that this species, the domestic sheep, may prove useful as experimental material for the solution of certain simple social problems of human beings.

In an analysis of this kind it is important to find out first the types of social behavior shown by the animal, second their relative importance, third the kinds

[1] This publication has been aided by a grant from the Committee on Faculty Publications, Wabash College. The author also wishes to thank the Committee on Visual Education, which assisted in the production of the moving picture.

of groups which are formed, and finally the organization within and between the groups.

## MATERIALS AND METHODS

The experience of earlier workers on social behavior has demonstrated the necessity of dealing with small groups of animals in which individuals can be easily recognized and whose history can be traced from birth onward. The experimental flock was therefore developed from two grade ewes and their lambs purchased in the spring of 1940 and observed over this and the following three seasons. Two orphan lambs from other flocks were added later. Eighteen individuals were observed altogether, fourteen being alive at the conclusion of the study. The two original ewes died and two lambs were slaughtered (see table 3).

As to care, the general aim was to raise the sheep with as little human interference as possible. The total range consisted of two adjoining fields of about one acre and four acres in extent and including one barn and two small sheds. Shelter was provided by leaving a shed and part of the barn open. Except at rare periods when snow covered the natural supply of food no artificial feeding was done. After the first year, when no rams were present, the males and females were separated from about September 15 to the early part of November. This made the lambing season come in late April, when mild weather made extra care unnecessary. No assistance was given the ewes during lambing.

Casual observations were made almost daily and more detailed studies were added at times when significant behavior was expected. The early morning just after sunrise appeared to be the most favorable time to observe social behavior, the animals being most active at that time. Periods of cool or cold weather also brought on unusual amounts of activity.

The following special types of observational study were made: (1) the daily round, consisting of behavior during an entire day, (2) the seasonal cycle, consisting of a record of behavior observed at various times of the year, and (3) development, the changes in behavior seen as lambs matured.

In addition, the sheep were observed under certain simple experimental situations described below, and moving pictures were taken of types of behavior which had been previously recognized.

## SOCIAL BEHAVIOR

It was found that the social behavior of sheep could be classified under eight general types, as given in table 1.

Many types of behavior may be either social or asocial. For example, a sheep may seek shelter under a tree or in a barn, a strictly asocial reaction, or it may attempt to find protection in the bodies of the other sheep, in which case it is definitely social. Any type of behavior may be considered social when given as a response to a stimulus from an animal of the same species, or when it has some effect upon such an animal. In the above list, eating, shelter-seeking and investigation are often asocial whereas the other five types of behavior are usually social.

TABLE 1

*Classification of social behavior observed in sheep*

- *Investigation*
  - Looking at other sheep
  - Touching other sheep with nose
- *Eating* (Nursing) (Plate II, e)
  - Nudging udder with nose
  - Sucking
  - Wiggling tail
- *Shelter-seeking*
  - Huddling together to keep off flies
  - Crowding together in extreme cold weather
- *Fighting* (Plate II, d)
  - Shoving with shoulders
  - Running together and butting
- *Allelomimetic behavior* (Plate I, b, d, e)
  - Walking and running together
  - Following one another
  - Grazing together
  - Bedding down together
  - Bouncing stiff-legged past an obstacle together
- *Epimeletic behavior* (in ewes only) (Plate I, g, h)
  - Baaing when separated from lamb
  - Walking around and around young lamb
  - Arching back to permit nursing
  - Touching lamb at base of tail with nose
  - Driving dogs away from lamb (stamping foot and rushing with head lowered)*
- *Et-epimeletic behavior* (Plate II, c)
  - Baaing by lamb when separated from mother
  - Baaing by lamb when hungry (bottle lamb only)
  - Baaing by adults separated from flock
- *Sexual behavior—Male* (Plate II, a, b)
  - *Courtship*
    - Hoarse baa or grumble
    - Running tongue in and out
    - Following female
    - Extending neck with upcurled lip, sniffing
    - Nosing genital region of female
    - Rubbing along side of female
    - Biting wool of female
    - Herding or pushing female away from other sheep†
  - *Copulation*
    - Wiggling tail (rare)
    - Mounting female
    - Thrusting movements of hind quarters
- *Sexual behavior—Female* (Plate II, a)
  - *Courtship*
    - Rubbing against male
    - Mounting male (rare)
  - *Copulation*
    - Standing still to receive male

* Combination with interspecific fighting.

† Combination with fighting.

Certain of the terms of classification used require explanation. Allelomimetic behavior is any type of activity which includes mutual imitation; it is extremely common among sheep. Epimeletic behavior is care or attention. In the sheep it is almost entirely confined to care of the lambs by the ewes. Et-epimeletic behavior is calling or signalling for epimeletic behavior. It is usually found in the lambs, replacing some adult forms of adjustment.

In the case of sexual behavior of the male, most of the courtship activities may be given in response to males as well as females. This corresponds to what would be termed homosexual behavior in human beings.

## DEVELOPMENT OF SOCIAL BEHAVIOR

The behavior of several lambs was observed soon after birth while the fleece was still wet. Much the same elements appeared in each case. For the most part the lamb would kneel upon the grass, but every now and then it staggered to its feet, went to the mother, and attempted to suck. The right spot might not be found until several tries had been made. As suckling began, the lamb would wiggle its tail, and the mother would occasionally turn around and touch the tail region with her nose.

At times it would nose and paw at straws and other objects on the ground. If the mother was lying down it would usually walk unsteadily over and lie down close beside her. It was usually silent, but if caught and held would emit a plaintive bleat which had an obviously disturbing effect on the mother.

Thus it is apparent that the social type of eating—nursing—is present in the newborn lamb, as well as et-epimeletic behavior, shelter-seeking, and possibly investigation. The going to the mother might be thought of as the beginning of allelomimetic behavior but, as observations on a pair of isolated lambs showed, training also has a profound effect on the development of this type of activity.

The first natural period in the lamb's existence extended from birth up to the time when it began to eat grass effectively, which happened at approximately ten days. During this time the ewe and her lamb were often found apart from the flock, the ewe grazing and the lamb lying down. At times she would baa,

---

PLATE I

All photographs are enlargements from motion picture frames (17)

a. Allelomimetic behavior, walking. Bighorn rams on Mt. Evarts, Yellowstone Park.

b. Allelomimetic behavior, walking.

c. Allelomimetic behavior, bedding down. Bighorn ram at top had previously driven other from upper position.

d. Allelomimetic behavior, bedding down and chewing cud.

e. Allelomimetic behavior, grazing. Large band of domestic sheep on Laramie Plains, Wyoming.

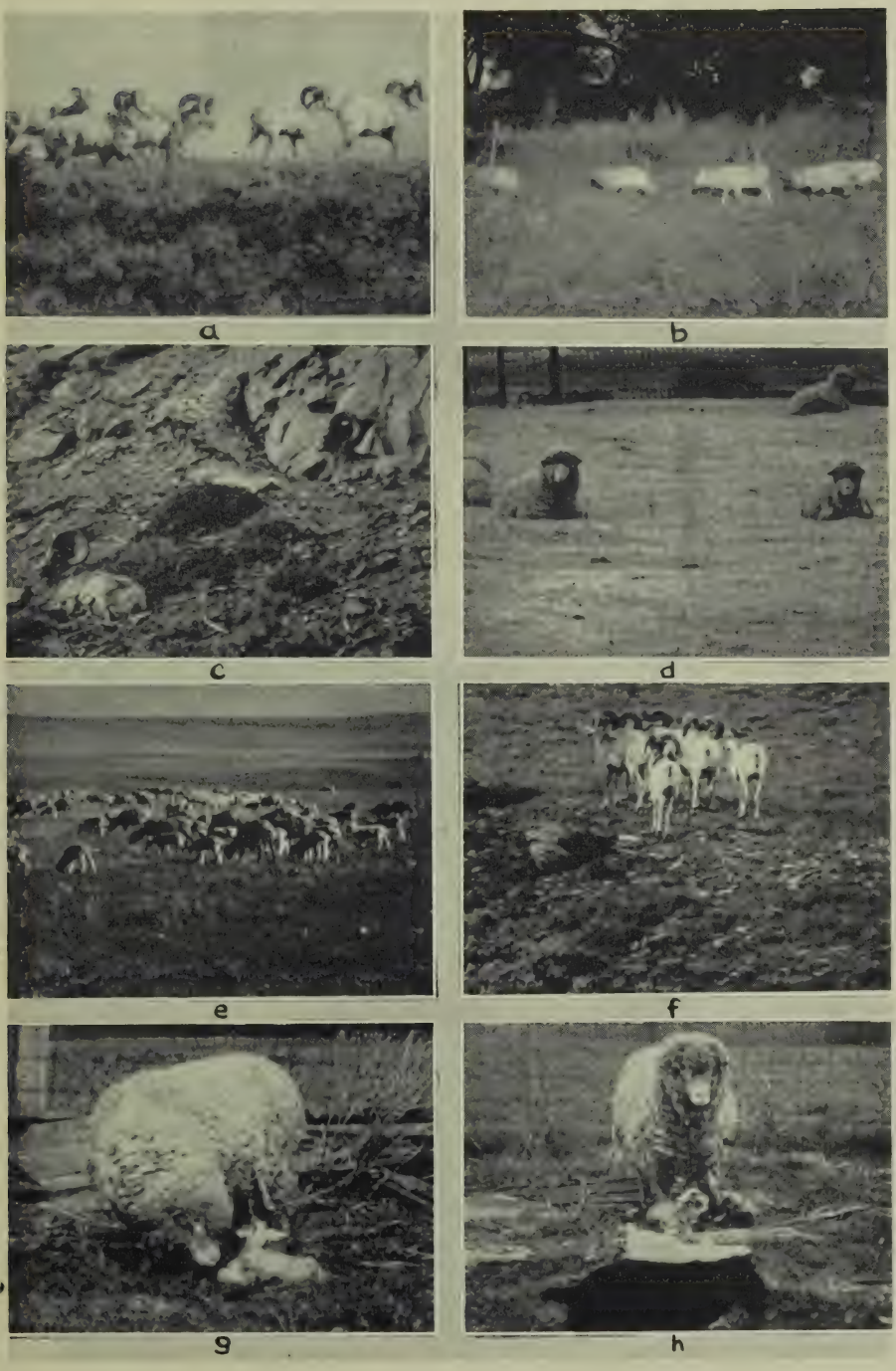
f. Allelomimetic behavior, bunching. Bighorn rams. Shows the typical close group which is formed when the flock is disturbed or frightened.

g. Epimeletic behavior, ewe nosing its new-born lamb.

h. Epimeletic behavior combined with interspecific fighting. Same ewe preparing to attack a small dog.

PLATE I

TYPES OF SOCIAL BEHAVIOR



and the lamb would get up, run over, and be allowed to nurse. Sexual behavior among male lambs was seen as early as three days in attempts to mount other lambs or even ewes.

The next natural period was a long one, running up to the time of weaning. The ewes soon rejoined the flock, and the lambs usually ran at their sides. However, there was an increasing tendency to join other lambs in play as the mothers grazed. It was observed that this "play" consisted largely of immature forms of adult behavior, and the types seen are classified below. It was during this period that allelomimetic behavior became very prominent, and fighting appeared in the form of playful butting. Sexual behavior of a ewe lamb was observed in one case, the lamb mounting another. This is rare in adult ewes, according to Mackenzie and Terrill (13).

TABLE 2

*Classification of various forms of playful behavior in lambs*

| |
|---|
| *Sexual* (Plate II, g) |
| Mounting back of lamb, by either sex |
| Smelling genital region of ewe |
| *Fighting* |
| Butting |
| *Allelomimetic* (Plate II, h) |
| Running together |
| "Gambolling" (bouncing stiff-legged and turning in air) together |
| "Game playing" (jumping on and off a rock or log) together |

After weaning the lambs were very nearly adults, since complete sexual behavior of ram lambs appeared invariably in the first autumn. In two cases ewe lambs were bred in the autumn of the first year, indicating that some ewes may also be sexually mature at this age.

In the two years following the maturity of the first ram lambs there were signs that the amount of fighting, especially in the autumn, was gradually increasing, though it never became frequent. It seemed probable that training played considerable part in the development of this type of behavior.

Epimeletic behavior in ewes always appeared after the birth of the first lamb, gradually dying away toward the end of the summer. It is probable that hor-

PLATE II

a. Sexual behavior, copulation.
b. Sexual (homosexual) behavior, courtship. Ram biting wool of another male.
c. Et-epimeletic behavior, orphan lamb. Hungry lamb baaing.
d. Fighting behavior, ewe and ram. This started immediately after shearing, when the ram attempted sexual behavior.
e. Nursing (social eating).
f. Nursing, orphan lamb.
g. Sexual play, mounting.
h. Allelomimetic play, gambolling.

PLATE II

TYPES OF SOCIAL BEHAVIOR, *continued*

mones are the important controlling factor in this type of behavior although a small amount was seen in one of the foundation ewes of the flock during a summer season when she was barren. This type of behavior was never observed in the rams.

The development of behavior was also studied in two orphan lambs isolated from the flock through the first period of development and fed from a bottle for several weeks thereafter. (Plate II, f.) The first of these, a female, was removed from the mother (belonging to another flock) on the day of birth and was kept completely apart from sheep until nine days of age, meanwhile being fed on the bottle.

When she was placed with the flock, her reaction to the other sheep was to investigate them, but she was driven off, sometimes with severe butting, by ewes having lambs of their own. After this had been repeated several times she paid no further attention to them but grazed by herself. She would come when called and would follow people, especially if continuously called or when hungry. She showed almost no fear of human beings or enclosed spaces. She showed very little tendency to play with other lambs, although they made some attempt to play with her. At times she was seen to gambol by herself, and she was noticed pursuing chickens around and around the chicken house. She would baa loudly when hungry and when she caught sight of the persons who usually fed her. All types of social behavior except allelomimetic appeared to develop normally. In this regard she showed only a rather poorly developed tendency to follow human beings. This might have been caused by early weaning (at ten weeks).

Thus it was supposed that allelomimetic behavior is developed by the continual repetition of the mother calling her lamb, it running up to her and being rewarded by being allowed to nurse. This may be thought of as a conditioning process continually reinforced. It was further supposed that the lamb generalizes from its experience with the mother (partly because she is always with other sheep herself) and thus learns to follow any other sheep.

This result was checked with another orphan lamb, a male, during the following year. From observations on other ram lambs, it was expected that it would be sexually attracted by other lambs at an early age and thus might be expected to develop somewhat more allelomimetic behavior. Unfortunately the two cases were not identical, the male being treated somewhat differently and weaned earlier. This lamb was one from another flock which had been rejected by the mother but had been left with the other sheep for four days. It was then isolated for eight days. When placed with other sheep it reacted in the same way as the ewe lamb and was driven off. It tended to feed apart from the others and be independent of their movements although not to such an extreme extent as the first. On the other hand, it continually came back to the other sheep and did exhibit considerable sexual behavior at this time. It was concluded that in the males sexual behavior probably causes them to follow other sheep and thus helps to develop allelomimetic behavior.

At any rate relative amounts of allelomimetic behavior exhibited by these two sheep at one year of age indicated that a lasting difference had been produced.

The female showed no tendency whatsoever to approach the flock until her first heat period and immediately thereafter left it. In cold weather she sometimes stayed in the same shed with the other sheep. When her lamb was born, next spring, she occasionally visited the flock in search of it. Apart from this her movements were entirely independent. The male sheep, at the corresponding age, was almost always found with the flock, although he might exhibit considerable independence while grazing.

### THE DAILY ROUND

When undisturbed the flock showed a tendency to follow a regular pattern of behavior throughout the day. However, this was greatly modified by changes in the weather and by the presence of annoying parasites.

In moderately cold weather the sheep bedded down for the night inside a shed. They arose shortly before sun-up and fed for three or four hours, following a fairly definite path around the fields. Then they bedded down again to chew the cud, usually on a sunny slope. This was repeated throughout the day, with as many as three feeding periods before the final bedding-down just before sunset. In severe weather the flock rose much later and the feeding periods might be reduced to two or even one. On the rare occasions when snow was on the ground the feeding movements were much restricted.

In hot summer weather the flock rested in the shade most of the day, avoiding heat and insects. Feeding and wandering were done at night.

With certain seasonal exceptions described below, the social behavior seen in the daily round consisted almost entirely of the allelomimetic wandering, feeding and bedding-down of the flock. (See Plate I, b, d, e.)

### THE SEASONAL CYCLE

The seasonal variations in behavior were in part under arbitrary control, being fixed by the date on which the rams and ewes were placed together to breed. Results are concisely represented in figure 1, but certain points need additional comment.

After the rams were admitted, sexual behavior of the ewes was never seen for more than two or three weeks, and then only for a day or so in each ewe. This agrees with the report of MacKenzie and Terrill (13) that nonpregnant ewes come into heat for an average of 29.3 hours every 16.7 days, from the middle of September until the middle of March. In most cases sexual behavior is limited to standing still for the ram. Thus a ewe which is bred in the normal fashion will show sexual behavior on only one or two days in the year.

This in turn limits complete sexual behavior of the rams to a period of a few weeks, but they have been seen approaching both ewes and rams in the manner of courtship in all except the summer months. According to MacKenzie and Berliner (12) rams will mount a female which is held for them during any season of the year but are less active in May and June.

Et-epimeletic behavior of the lambs declined very rapidly after weaning, but never entirely disappeared even after they reached maturity.

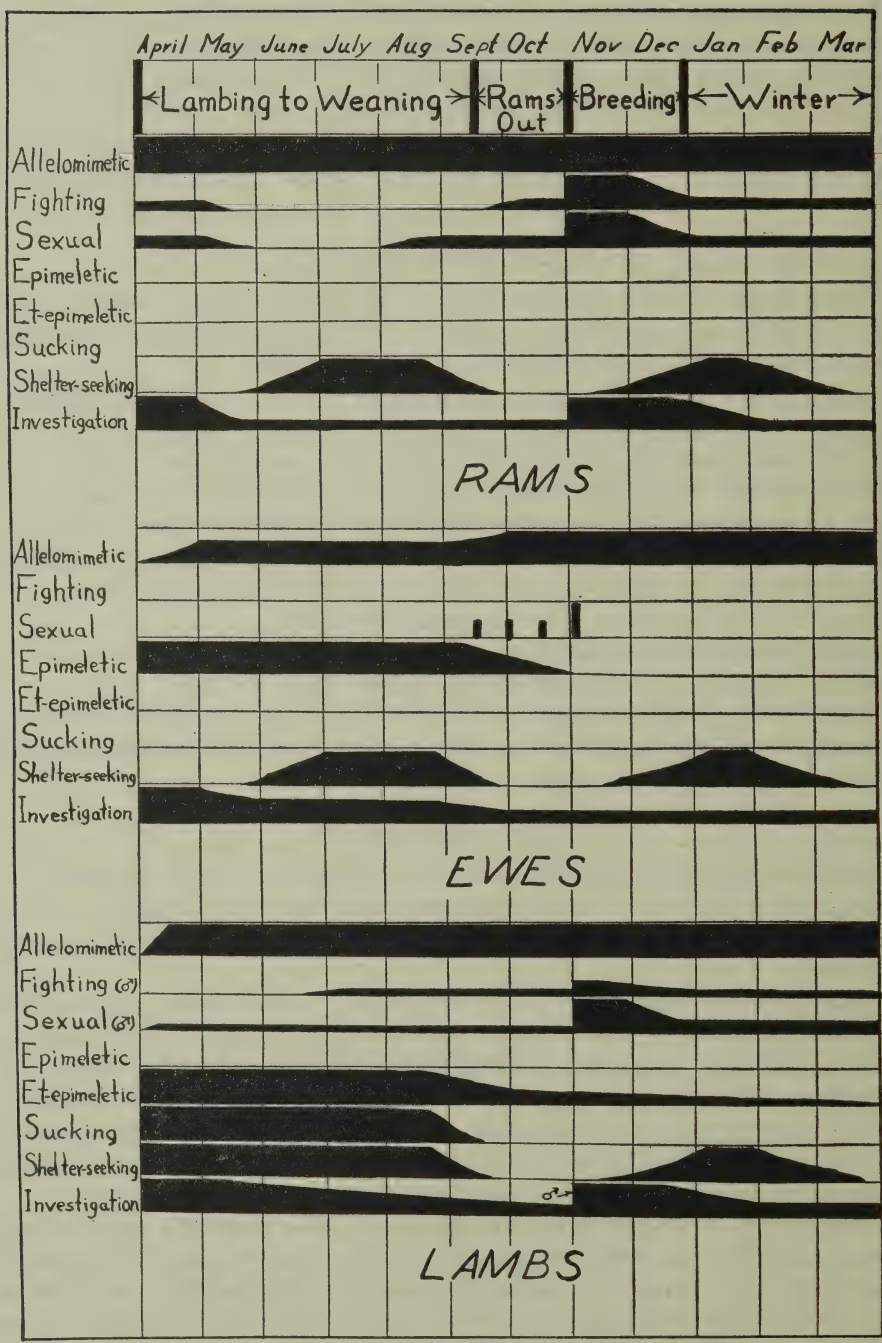



FIG. 1. SEASONAL OCCURRENCE OF SOCIAL BEHAVIOR

Maximum thickness of each horizontal bar indicates the season at which the greatest amount of the corresponding type of social behavior was observed.

Serious fighting has been rarely observed in this flock. The milder forms of butting and shoving between the rams appeared to increase during the autumn months and were associated with sexual behavior, whether one or both sexes were involved. (Plate II. d.)

Allelomimetic behavior of rams was little affected by the seasons. In the ewes epimeletic behavior interfered with it to some extent during the spring and summer months. As will be discussed later, this appeared to have an important bearing on the position of ewes as leaders of the flock.

With regard to the social type of shelter-seeking, the sheep in summer often huddled together to avoid the insects which hovered around their heads, and in the winter they occasionally crowded together for warmth.

Investigation increased at the times of lambing and breeding, probably because of physiological changes in the members of the flock. Ewes in heat or which had recently given birth to lambs apparently had a different smell, and showed a decided change in behavior.

While the seasonal cycle of social behavior in these sheep was not as clear-cut as those seen in birds, where certain types of activity may appear and disappear almost overnight, three fairly definite seasons were obvious.

The first of these ran from lambing through weaning and was marked primarily by the epimeletic behavior of the ewes and the et-epimeletic behavior and nursing of the lambs. During this period there was a tendency for ewes and rams to separate.

The second was the breeding season, which was arbitrarily started early in November and continued for approximately a month. This period was marked by sexual behavior of ewes and rams and mild fighting between the latter.

The third or winter season followed, continuing up to the lambing season in April. The prominent type of behavior was allelomimetic, and the flock was usually closely bunched at this time of year.

Five of the types of behavior described, sexual, epimeletic, et-epimeletic, nursing and shelter-seeking, were definitely present in some seasons and absent in others. This indicates that the classification of social behavior used is one which has a natural basis. The other three types of behavior merely showed seasonal variation, but two of these, allelomimetic behavior and fighting, have definite seasonal stopping and starting points in other animals, especially birds (2). Thus the seasonal analysis of behavior supports the assumption that the classification of social behavior used is a valid and natural one.

As remarked elsewhere (17) the relative importance of the more highly social types of behavior may be ranked as follows. For rams: allelomimetic, sexual, fighting. For ewes: allelomimetic, epimeletic, fighting, sexual. This difference between the sexes apparently has considerable effect on the formation of groups.

## GROUP FORMATION AND SOCIAL BEHAVIOR

The above accounts of the daily and seasonal life in the flock indicate that from birth to death each sheep was part of a group. This was almost literally true.

Analyzed according to their composition, the following spontaneously formed groups were observed (1) ewes, (2) rams, (3) lambs, (4) ewe and ram or rams, (5) ewe and lamb, or ewes and lambs, and (6) ewes, rams and lambs. These groups were not found all at the same time nor with equal frequency, but they do include all possible combinations except that of rams and lambs.

It was readily apparent that each type of group was associated with a particular type or types of social behavior. Natural groups including ewes only were found in the early summer when the lambs were young. The ewes grazed together while the lambs, which at that time obtained a large proportion of food from nursing, played in another group a short distance away. (Plate II, h.) The social behavior in both groups was predominantly allelomimetic.

The same season also saw the natural formation of ram groups. The ewes and their lambs tended to move slowly, while the rams ranged more widely in their own groups, sometimes accompanied by a barren ewe. There was a tendency for rams born in the same year to stick together. (Plate III, c.) Here again the predominant type of social behavior was allelomimetic, with occasional instances of sexual (homosexual) behavior between the rams. (Plate II, b.)

For a few hours after the birth of a lamb, and sometimes for a few days, a ewe would stay with her lamb while the flock moved on. Here the prominent types of social behavior were epimeletic on the part of the mother, and et-epimeletic and nursing by the lamb. As soon as the lamb could walk easily the pair would join the other ewes with their lambs (Plate III, b), allelomimetic behavior appearing at this time.

The ewe-ram group (Plate II, a) was found during the mating season, and was only temporary in nature. A ewe in heat would be pursued by all the rams and often become separated from the rest of the flock. One of the older rams occasionally succeeded in separating such a ewe from the other rams. Sexual behavior was common, with occasional mild fighting between the rams as they got in each other's way. If no ewe was in heat, the ewe-ram-lamb group was formed.

This latter inclusive group could be formed temporarily at any time, but was most prominent in the late summer, autumn and winter, excluding the time when the rams were artificially separated from the rest. The predominant type of behavior was allelomimetic, with considerable sexual behavior (attempts at courtship) on the part of the rams. Gradually decreasing amounts of epimeletic and et-epimeletic behavior were seen as the lambs matured.

Shifting the analysis to a purely theoretical basis, it can be seen that seven of the eight types of behavior recognized above can cause the formation of groups on occasions. The exception is fighting, which has almost invariably a dispersive effect. However, only five of the seven—allelomimetic, epimeletic, et-epimeletic, nursing and sexual behavior—are important in the sheep. Shelter-seeking occurs only under certain special environmental conditions, and investigation, since it seldom lasts long, contributes little to the formation of groups

Referring back to figure 1, it can be seen that the social form of eating, nursing, is found only in lambs, and that et-epimeletic behavior is rarely found except in the young animals. Epimeletic behavior is only found in the ewes. Sexual behavior lasts much longer in rams than in ewes. Finally, allelomimetic behavior of mature animals is *absent* only in the ewes for a brief period following the birth of a lamb. Except for this brief period, then, the behavior in any group must consist of allelomimetic activity, either alone or in combination with some other sort or sorts.

If allelomimetic behavior alone was present, it would be expected that each type of sheep, the rams, ewes and lambs, would tend to form a separate group, because it would be easiest to imitate the most similar animals. This would account for the formation of the lamb, ewe and ram groups described above.

The addition of sexual (homosexual) behavior to the ram group would be expected to add to the cohesion of that group. In actual observation this appears to be true except when the resulting frustration leads to mild butting and fighting.

The combination of epimeletic behavior in a ewe and nursing plus et-epimeletic behavior in her lamb would be expected to produce a lamb-ewe group, and the addition of allelomimetic behavior would be expected to draw the pair to other similar pairs. This is confirmed by observation.

Finally, the lamb-ewe group and the ram group should be drawn together during the fall and winter months by the sexual behavior of the males, and occasionally by that of the females, forming the combined ewe-lamb-ram group. This again is found to conform to observation.

As a negative check, there should be no ram-lamb group, as the rams do not show epimeletic behavior. No such group has been observed.

It can be tentatively concluded then, that group formation is caused by social behavior.

It should be noted that certain of the above groups were also groups of groups. The important fundamental groups in the flock appeared to be the ewe and her offspring, and rams born in the same year. The lamb-ewe group included many ewe-offspring groups, and the ewe-ram-lamb group combined these with the ram group. This has an important bearing on the question of leadership in the flock, as will be shown later.

It should be further noted that no group corresponding to the human or primate family group of male(s), female(s) and offspring was found in the sheep; the sheep family group consisted of mother and offspring. (Plate III, a.) Furthermore, the limit of complexity of organization in the flock described appears to have been reached in the formation of the six groups described above; there is no further division of function between groups.

## RELATIONSHIPS

Among human beings the concept of relationship is a very important one. The idealogic basis or code of behavior may differ in different cultures but the

end result is always that a particular pattern of behavior is laid down between one specified individual and various others. Any relationship may belong to one of two types: specific relationships, in which only one other individual is involved, or a general relationship in which each of several others may be involved. For example, in our society a child has only one mother, but may have several brothers.

There is of course no idealogic basis for relationship in the sheep. However, it was found that certain combinations of social behavior occurred only between certain individuals and the idea could thus be applied. The concept is especially useful for studying social organization within a large group: in effect, a related pair may be thought of as the smallest possible natural group.

In the flock studied there appeared to be four main types of relationships, one specific and three general. The sole specific relationship was that between a lamb and its mother. General relationships occurred between, (1) a ewe and

TABLE 3

*Social relationships in the experimental flock (females italicized)*

| | | | |
|---|---|---|---|
| *A* | *B* | | |
| *A*-1 | *B*-1, B-1′*† | | |
| | B-2, B1-2 | $C2_0$‡ | |
| A1-3, A1-3′* | *B*-3, B1-3† | $C2_0$-3 | $D3_0$‡ |
| *A*1-4, A1-4′ | *B*1-4 | $C2_0$-4 | |

′ Twin.
* Castrated male.
† Slaughtered.
‡ Orphan lamb.

various rams, or a ram and ewes, (2) between a lamb and other lambs born in the same year, this relationship apparently being stronger between males than females, and (3) between a young sheep and any older sheep.

On this basis was devised a simple classification scheme which indicated the important types of relationship. The family line was denoted by a letter and the year of the animal's birth by a number. By adding a hyphen and number to the mother's classification the complete ancestry of any individual was indicated. As seen in table 3 ewe B (year of birth unknown) had in the first year twin lambs, B-1 and B-1′. In the second year she had a second lamb, B-2 and her lamb of the previous year also had a lamb, B1-2. (Plate III, f.) This system may be extended as far as would ordinarily be necessary in an experimental flock, and if sex is indicated, all relationships between any two animals can be easily worked out by comparing the classification symbols.

The behavior observed in each type of relationship may be described as follows:

The behavior between the young lamb and its mother was of course the typical epimeletic, et-epimeletic and nursing combination; this developed into allelomimetic behavior of the lamb and the tendency after weaning to continue to

follow the mother. At this point epimeletic behavior of the mother largely ceased and thus no general relationship between the mother and all her offspring of previous years was developed.

This relationship appeared to be stronger among female than male lambs. Among the original four animals which were the foundation flock, there was a castrated male lamb and it was observed that this animal followed its mother closely and as long as its female twin. It was supposed that sexual behavior might cause the male lamb to leave its mother more frequently and thus break down the relationship more rapidly. This hypothesis was tested in the case of the twins A1-3 and A1-3′, the latter of which was castrated at six days of age. During the autumn both these rams were separated from the mother and placed with the male flock. When returned, the castrated animal showed no sexual behavior but likewise no obviously greater tendency to follow the mother than its twin. It was concluded that the important factor in breaking down the relationship between male lambs and their mothers under these conditions was probably not sexual behavior but simply the complete separation of mother and lamb. It follows that the lamb-ewe relationship is strongly modified by training.

The relationship between lambs born in the same year apparently consisted largely of allelomimetic behavior and a tendency to stick closely together. (Plate III, c.) This was especially noticed when the rams were separated from the rest of the flock; in this situation there was also some homosexual behavior. This relationship seemed to develop out of the play group of young lambs.

The relationship between a ewe and rams was of brief duration, lasting only through a heat period. It consisted of sexual behavior. On the other hand, the relationship between a ram and ewes extends over a much longer time. During the cooler months, a ram makes sexual approaches to any ewe and tends to follow her.

Finally the relationship between a young sheep and any older one consists of allelomimetic behavior and a tendency to follow the older sheep. This relationship apparently grows out of a generalization from the lamb-ewe relationship. Older sheep, on the other hand, pay little attention to younger ones and little relationship is apparent.

This type of analysis leads naturally to conclusions regarding leadership. Since there is a tendency for lambs to follow their mothers, and males to follow females and for younger sheep to follow older ones, it can be concluded that in most cases the oldest ewe should lead the flock. This expectation was confirmed in the observations described below.

### PROSTASIA

This term may be defined as the phenomenon of causing the behavior of another animal or animals of the same species in any way, either positively or negatively. In most actual situations causation is likely to be reciprocal, and where there is unequal prostasia between two animals the one exercising the greater amount of control may be called superordinate; the one exercising the lesser amount of control, subordinate.

With this general definition it is obvious that prostasia may be produced in connection with almost any sort of social behavior. The behavior can be that of the superordinate sheep and so act as a cause, or be that of the subordinate partner and so be the effect. The most important cases of prostasia seen in the flock are given below, the direction of stimulation or causation being represented by arrows.

*Et-epimeletic* ⟶ *epimeletic.* A demonstration of this type of prostasia was produced by separating the lamb and mother and restraining the former. The lamb called (et-epimeletic behavior) and the ewe came running up to it, touching it and allowing it to nurse (epimeletic behavior).

*Epimeletic* ⟶ *nursing, allelomimetic.* If mother and lamb strayed apart, the mother would baa (epimeletic behavior) and the lamb would run up to the mother and nurse. Afterwards the mother and lamb would move off together (allelomimetic behavior). This was also done experimentally by separating the lamb and mother and restraining the latter. This form of prostasia occurred over and over again during the early part of the summer.

*Allelomimetic behavior.* By its definition of mutual imitation this term implies the existence of reciprocal prostasia. A situation in which the prostasia was nearly equal was observed over and over again as sheep were frightened by cars or trucks passing the field. The scattered flock would be grazing peacefully, heads down. At the onset of the disturbance heads would be flung up and each sheep would start running toward its nearest neighbor. When a close bunch had been formed, they would all move off together in a direction away from the disturbance (allelomimetic behavior).

On the other hand, allelomimetic prostasia of a very unequal nature was observed in mothers and lambs. When moving young lambs followed their mothers in almost every case. The mothers began to show considerable independence of other sheep after the birth of the first lamb and this tendency increased with age. Since the other sheep retained their tendency to follow, the flock was usually led by the oldest ewe. This type of prostasia appeared to be most important both in frequency of occurrence and number of animals affected. One old ewe often led the entire flock. (Plate III, e.)

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PLATE III

a. Lamb-ewe group, winter season, in combined flock.

b. Group of lambs and ewes, lambing season.

c. Ram group, all born in year 3. Rams tend to stick with those born in the same year.

d. Interspecific group, orphan lamb and child.

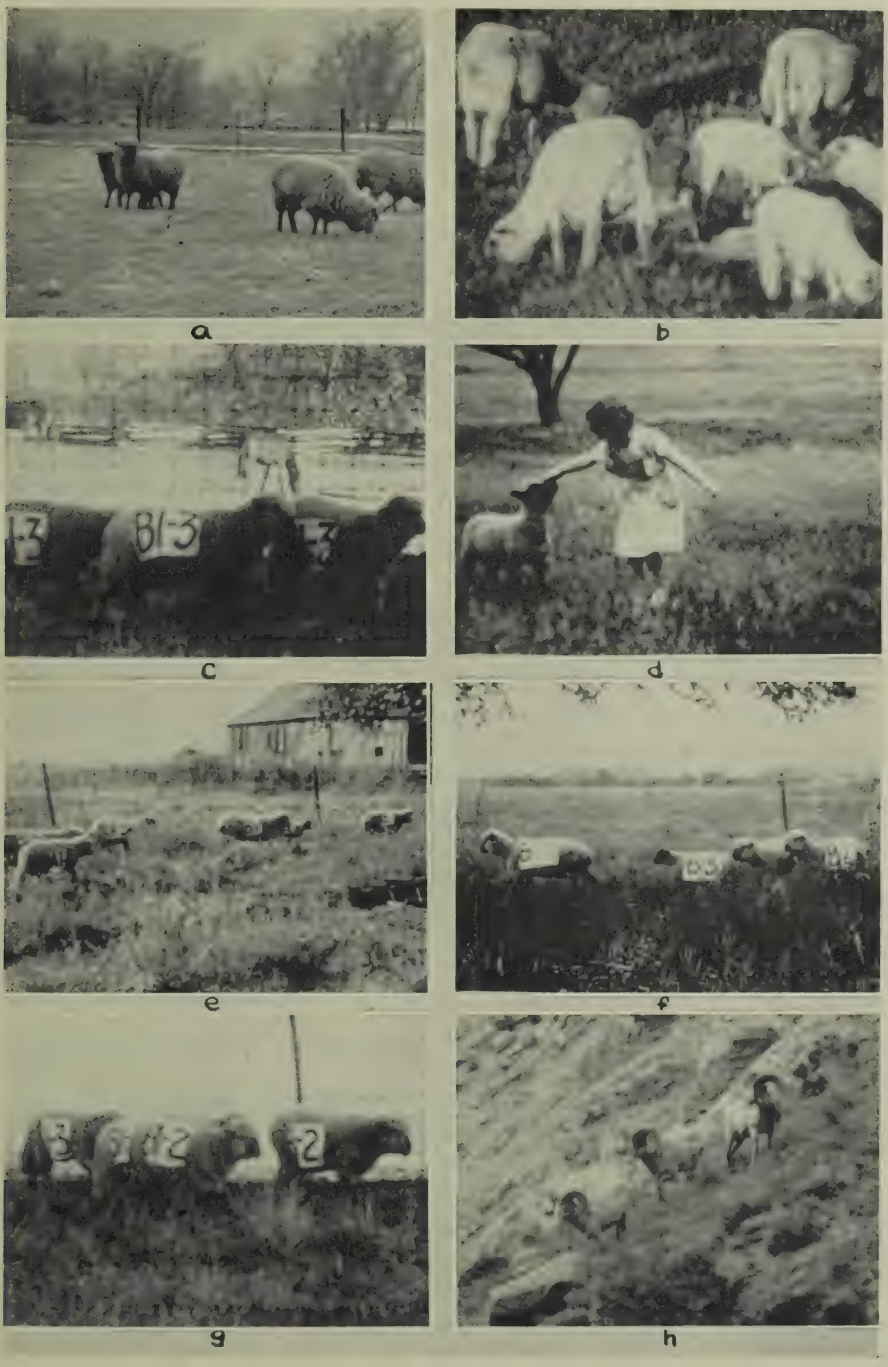
e. Prostasia, allelomimetic unequal. The oldest ewe, B, leads the flock, followed by B-3, B-1, B1-3, B-2, A1-3, and others.

f. Prostasia, allelomimetic unequal. The oldest ewe, B, leads her descendents, B-3, B-1, and B-2.

g. Prostasia, allelomimetic unequal. Ram group. Rams of year 2 lead those of year 3.

h. Prostasia, allelomimetic unequal. Bighorn rams. Movement started by ram in the lead.

PLATE III
SOCIAL GROUPS AND LEADERSHIP



*Sexual ⟷ sexual.* When a ewe happened to come into heat reciprocal prostasia in connection with sexual behavior was observed, each animal stimulating the other and staying close beside it. Allelomimetic prostasia of an equal type was observed at the same time and as a partial result.

When the ewes were out of heat the prostasia became very unequal. Ewes stimulated the rams but were not stimulated themselves and the rams followed them everywhere, producing unequal allelomimetic prostasia as well. This effect was particularly noticeable when the rams and ewes were put together after separation. A single ewe might be avidly followed by a string of five rams.

*Fighting ⟶ fighting, moving away or inhibition.* Under ordinary conditions there was no fighting over food. However, a mild type of aggression was produced by putting down a small amount of corn in a limited area during the winter season. The older and larger sheep began pushing and shoving, mostly with the shoulders. The largest ram usually got the food, but not all of it. After a few trials of this sort, the younger and smaller sheep merely stood passively by.

A slightly more serious type of fighting occurred between rams following the same ewe in heat. One would mount the ewe, only to be butted aside by a second, who would then be served in a like manner. The largest ram usually succeeded in driving off the rest after some effort.

This last type of control is the only type of prostasia which can properly be called dominance[2] as the term was at first used by Yerkes (22). The basic methods of control in the above examples appear to be (1) the stimulation of an automatic control center as is apparently the case when the ewe stimulates the new born lamb, when the lamb stimulates the ewe who has never had a lamb before to epimeletic behavior, and in sexual behavior; (2) rewards, as when the lamb is allowed to nurse when it follows the ewe and (3) force, as is the case when one ram drives another away. To these may be added the stimulation of higher control centers involved in training, as when an old ewe leads a younger sheep which has learned to follow others.

It appears that rewards, training and stimulation of innate behavior patterns were far more important types of control in this flock of sheep than was dominance (prostasia based upon force). On the other hand, the last might easily become somewhat more important in other sheep because of different training or artificial methods of feeding.

These observations lead to the conclusion that of all types, allelomimetic prostasia, especially that involving the leadership of the flock by the oldest ewe, was the most important in the flock, both in frequency and in the number of individuals affected. Because of this it was thought advisable to observe it under controlled conditions and to test one of its more important component factors, the tendency of young lambs to follow their mothers and any older sheep. Other factors not tested were the experience of the older sheep in ad-

[2] In a previous note (18) the author used the term "allelomimetic dominance." However "dominance" appears to be so widely associated with the idea of control by force and fighting that it seems wiser to use it only in the restricted sense.

justing to similar environmental situations, and the tendency of males to follow females.

### TESTS OF ALLELOMIMETIC PROSTASIA

When there was any general stimulation of the flock the young lambs showed a tendency to crowd close to the sides of their mothers and to remain there until the mother moved along. Presumably this meant that the lamb was conditioned to follow the mother by repeated prostasia of the latter. Each time the lamb came to its mother it was nuzzled and allowed to nurse. The lamb apparently generalized from this to follow any other sheep.

Older sheep, while showing some tendency to come closer to the others when disturbed, would often take some partially independent action, such as moving toward or away from the stimulus. This can be theoretically explained as follows: after weaning the response of following the mother is no longer reinforced by a reward of food and hence becomes weaker. The response of following older sheep is never so reinforced. Epimeletic behavior after the birth of a lamb separates the ewe from the flock and further weakens the response, as well as conditioning the ewe to take the lead.

The first test was made as an objective check on the previously observed tendency of older sheep to lead younger ones. It was noticed at shearing time that it was difficult to get the flock to enter a barn or shed unless one of the older sheep took the lead, even this being done after considerable hesitation.

A similar situation was devised as a simple test of leadership. All sheep were penned up in one building out of sight as viewed from the testing ground. They were removed, one pair at a time in all possible combinations, driven through an unfamiliar opening into a small shed, and then released into an open field. The sheep which entered first was noted as each pair went in.

As was discovered in practice, the free sheep occasionally attracted the attention of those being tested; the technique could have been improved by returning the pair to the rest of the flock after each observation. Each member of a pair had the same amount of experience at the time of comparison, but it was noticed that experience still had an effect, the sheep tending to enter the shed more readily after the first few trials.

The orphan lambs were included in this test, but their reactions are best analyzed separately.

Observations on mothers and their offspring of all ages included only a small number of pairs, even after a similar test was made a year later. In the total results the mothers led in 11 out of 13 pairs; the probability of such a result being obtained by chance being .022 according to Warwick's (21) tables. Three of these cases duplicated the test pairs of the year before, and the results are still on the borderline of significance.

There remained in the first year 26 pairs of younger and older unrelated sheep. In 20 cases the older one entered the shed first. If it is assumed that age was an unimportant factor and that it was purely a matter of chance which sheep entered first, the ideal result should have been a 13:13 ratio. The chance of

getting a 20:6 ratio or one in worse agreement in either direction is .0092. It was concluded that in this flock and in this situation there was a definite tendency for older sheep to lead the younger (18), whether related or not.

In this test there were at least two factors present which may have contributed to the leadership of the older sheep: their greater experience with similar situations, and the greater tendency of the younger sheep to follow. Another situation was then devised which would chiefly involve the latter and apparently more important factor, and the flock was so tested during the autumn of the fourth year at the time when the males and females were separate.

The sheep were confined to the barn as before. A single pair was removed and driven to a point near a fence, either in a corner or along a straight section. When they had stopped moving and while both had their attention on the driver, he walked quietly toward them and the fence in a direction which would separate them if they stood still. The sheep could move in either direction, and the one which led was noted. The pair was then driven along to another place and the observation repeated, for a total of 10 times.

The results can be interpreted in two ways. If there were no tendency to follow, and since there was a choice of two directions, it would be expected that the two sheep would go in opposite directions half the times. Among the males the two sheep went in different directions only twice in 100 observations. The same result occurred only once among the females in the same number of observations. It may be concluded that there was a strong tendency among these sheep to follow another which had taken the lead.

The method may also be used to determine whether one sheep consistently follows another. Definite results may be assumed when one sheep follows the other at least nine out of ten times, since the chance of getting this in the absence of any consistent tendency is .0216.

When all cases were added together comparisons had been made between 14 pairs of younger and older unrelated sheep, in eight of which the younger consistently followed the older. The younger sheep followed the older in 111 out of 140 individual observations. The probability of obtaining by chance more than two cases of consistent following in a group of this size is approximately .02, and the probability of getting as many as eight cases is extremely small. There were no cases of older sheep consistently following younger ones. It was concluded that in this flock and in this situation definite cases existed of younger sheep consistently following older ones. Any further partial tendencies to follow were not measured.

The complete data may be summarized as follows. The male flock consisted of two sheep in generation 2, two in generation 3, and one in 4. There were eight pairs of younger and older sheep, and two of these showed consistent following, both by the lamb of generation 4. In the female flock there were two sheep in generation 1, one in generation 3, and two in generation 4. All six pairs of unrelated younger and older sheep showed consistent following. Classifying both flocks by age showed that six out of eight pairs including a lamb of year 4 gave consistent following, while only two out of six pairs including a sheep of

generation 3 as the youngest gave the same result. This agrees with the hypothesis that the tendency to follow wears off with age.

However, the numbers involved are too small to allow any definite conclusions to be drawn regarding these indications of differences caused by sex and maturity.

Evaluating these results in the light of the original hypothesis, it may be said: if young lambs were not trained to follow their mothers they would be expected to separate from the mothers in half the cases and to follow them in only half the remainder. Actually all three lambs followed the mother in ten out of ten trials. If lambs did not generalize to follow other unrelated sheep the same frequent separation would be expected. Separation in such cases actually happened in less than two per cent of the trials. If the tendency to follow did not wear off with age both members of a pair would be expected to simply bunch together (as pairs of young lambs were seen to do) and there could be no cases of consistent following except by accident, the probability being .0216. Actually, there were no cases of older sheep consistently following younger ones, and younger sheep definitely followed older ones in eight out of 14 cases.

Thus these data fully confirm the hypothesis that unequal allelomimetic prostasia in this flock was partially caused by the young lamb's being trained to follow its mother, generalizing to follow other sheep, and later gradually losing the effect of the training as it was no longer reinforced with a reward.

The result should have been that the oldest ewe should lead the flock on most occasions. In the course of the first series of experiments the whole flock was driven into the barn 10 times. In 9 cases it was led by the oldest ewe, B. The chance of getting such a result by chance out of a flock of 12 sheep is almost infinitesmal.

### ABNORMAL BEHAVIOR

This may be defined as behavior showing a wide deviation from that of the average in any direction. For the most part efforts were made to keep behavior as natural as possible, but certain interesting exceptions were observed.

The ewe B-1 was partially "wool blind" except immediately after shearing. She would often miss seeing disturbing factors or movements of the other sheep, later notice what had happened, and dash off after them. In the test of entering the shed she was unusually hesitant and led only three out of six unrelated young sheep.

In the case of the orphan lambs a deliberate attempt was made to modify social behavior, with the consequences described in a previous section. Putting these sheep through the tests for allelomimetic prostasia confirmed these observations.

Rearing by and among human beings apparently produced at first (*a*) a sense of familiarity with enclosures, (*b*) a tendency to follow human beings without fear, and (*c*) some tendency toward independence of the movements of other sheep. As might have been expected, their reaction in the test of entering the shed was to plod directly into it with little hesitation and few attempts to escape, and this gave them some advantage in leadership. The female led four out of

five younger sheep, two out of three older ones, and one out of two the same age. The male (which was a lamb at this time) led three out of five sheep the same age and followed all older ones.

The lack of fear of the driver and the independence of other sheep might have been expected to produce opposite effects on the second or separation test. However, a year later the behavior of both sheep had changed. The older was now somewhat more fearful of human beings, and the younger stayed with other sheep more often, presumably because of sexual behavior. When the separation test was given, the ewe showed great independence, separating from the others in six out of 70 trials (as compared with 3 out of 200 in other sheep), while the ram separated only once in 50 trials. The ewe followed no other sheep consistently, but was consistently followed by all three unrelated younger ones, while the ram consistently followed two older sheep and two the same age and was not so followed even by a younger lamb.

Both orphans appeared to show less fighting than other sheep. The ewe did not butt other lambs away from her although she did not allow them to nurse, and the ram was not aggressive toward other males even in the breeding season. The cause of this effect is not obvious.

The ewe also showed a considerably reduced amount of epimeletic behavior toward her own two lambs. Whatever the cause, it produced a marked effect on the behavior of the latter.

Their mother was not only indifferent to other sheep but showed little concern for her current lamb, reacting only mildly when separated from it. The lamb apparently learned to follow its mother and generalized to follow other sheep but in consequence of the mother's wandering often became separated from her, sometimes calling and receiving no reply. As a probable result, the lamb showed some independence of both the mother and the flock and in addition was unusually fearful and nervous.

Both $C2_0$-3 and $C2_0$-4 were affected in this way and this was reflected in their tests of following. They usually attempted to escape the driver long before the other sheep and consequently often led. Neither showed a consistent tendency to follow any other sheep. They were the only cases where offspring did not follow the mother. On the other hand each was followed by three sheep; one of these being older, the only observed case of an older sheep consistently following a younger unrelated one.

These cases have an interesting human parallel which may be worth mentioning. According to psychiatrists, the frustration resulting from lack of adequate parental care and affection may result in lack of confidence and nervousness. The same thing is likely to happen when there is a conflict between parental training and that received elsewhere. Both factors seem to have affected these lambs, resulting in an unusual degree of fearfulness, as well as a reduced tendency to follow other sheep under certain conditions.

None of these cases included definitely nonadaptive or neurotic social behavior. However, they do give indications that certain other factors than the tendency to follow may also affect allelomimetic prostasia: (*a*) familiarity with the physical

environment, (*b*) disability involving sight and (*c*) relatively strong or weak sensitivity to stimulation. The first and last of these appeared to be directly correlated with early training, as did the abnormal behavior concerned.

## DISCUSSION

The small numbers of animals used in the above study are at once its strength and its weakness. Small numbers made it possible to identify each individual and follow its behavior from birth onward, to analyze relationships and to determine leadership. On the other hand, the total numbers were too small to permit the conclusion that the results apply to sheep in general. It therefore became important to discover whether they agreed with observations of other authors.

Many scattered references to the behavior of sheep are found in books concerned with the history and breeding of these animals. For example, Coffey and Kammlade (4) mention the ewe recognizing her lamb by smelling it, the strong tendency to flock together, especially when alarmed, and the tendency to follow a leader. They consider the flocking habit (or allelomimetic behavior) to be strongest in the Merino sheep and weakest in the Black-faced Highland, the latter observation agreeing with that of Darling (6).

The detailed descriptions of sexual behavior given by McKenzie and Terrill (13) coincides with and extends the observations listed in the present paper.

Coffey and Kammlade, together with most other authors, assume that the behavior of the sheep is largely instinctive, but the experimental work of Liddell and others (11) shows that it can be readily conditioned, which is in line with the author's conclusion that learning is an important factor in allelomimetic behavior and leadership. It is probable that heredity plays an important part in molding behavior but that it is also modified by learning. Heredity seems to be most important in sexual behavior, nursing, and epimeletic behavior, and somewhat less so in allelomimetic.

A few observations on social behavior have been made in connection with psychological studies on sheep. Liddell (10) noticed the formation of lamb groups separate from the mothers at the age of two months and that lambs trained in mazes showed a long memory of the solution. Curtis (5) measured the activity of sheep in late October, finding only 22 per cent of the walking was done at night, and that cold nights might reduce this by nearly one-fourth, agreeing with the seasonal changes in the daily cycle of activity as described in this paper.

Thus the observations recorded for the author's small flock seem to agree with the general nature of sheep behavior as partially described by stock breeders and animal psychologists. The system of leadership finds little mention in their reports, partly because good economic practice demands that ewes be sold when relatively young and that a minimum number of rams be kept, and partly because sheep may be kept either in crowded lots or in such large numbers that leadership cannot be analyzed if indeed it exists at all.

An even more interesting parallel exists between the present study and those made on the wild mountain sheep or bighorn. In the summer of 1942 the author was able for a brief period to make observations on what were probably two

bands of male bighorn on the slopes of Mt. Evarts in Yellowstone Park. The behavior was chiefly allelomimetic. (Plate I, a.) The animals bedded down together at night on rocky slopes. Early the next morning they left together, usually walking single file along trails, and grazed together on open slopes and grassy ravines. At intervals of several hours they would bed down, usually close together. This confirmed the descriptions of the daily cycle given by Gammill (8), Mills (14), and Davis (7), and is closely similar to that of the domestic sheep. When alarmed, the rams responded by running toward each other and "bunching" and then running off together. (Plate I, f.)

One ram was seen to paw the back of another with stiffly extended fore-leg, a probable case of sexual behavior. On two occasions a mild sort of fighting was observed. Both of these occurred while the flock was bedding down under a cliff, one animal driving the others away and scratching a resting place for himself in the highest position. (Plate I, c.) In both cases, when an allelomimetic movement of the flock occurred soon after, it was led by another ram which appeared to be older and weaker. (Plate III, h.) This agrees with the observations in domestic sheep, that more than one kind of prostasia exists and that the same individual may not lead in all kinds.

Other authors confirm the close resemblance between the behavior of domestic sheep and that of the bighorn. The Chapmans (3) give an extended picture of behavior during the breeding season, the elements being almost precisely the same but the vigor being greatly increased. Spencer confirms this and remarks that the young lambs form a flock of their own while their mothers are feeding. The biggest differences appear to be (*a*) the migrations, (*b*) the extensive fights during the breeding season, and (*c*) the complete separation of ram and lamb-ewe flocks except during the breeding season. All these things appear to be directly connected with the superior size and vigor of the wild species, plus the fact that their range is less limited.

If the same factors are responsible for prostasia in the wild species it would be expected that the allelomimetic leadership would ordinarily go to one of the oldest rams in the ram flock, and to the oldest ewe of a flock of ewes. Honess and Frost (9) remark, "Almost every flock of rams has its recognized leader," and Seton (15) reports (somewhat subjectively), that the leader of the flock is a wise old ewe. Davis (7) says, "Individualism was shown by some of the sheep, particularly by 'Broken Horn' the old lambless ewe that led the flock on most occasions." Gammill (8) reports that the movement of the bunch is usually initiated by one animal.

Suggesting that maternal emotions covering the entire herd are stimulated by the birth of young, Darling in his studies of the red deer of Scotland reports that the older does tend to become the leaders and that they lose their positions if they become barren (6). In the flock of sheep studied the old ewes became leaders partly because their own tendencies to follow were reduced while caring for the young. Darling also observed that stags of the same age tended to stay together, and that there was no obvious leader though one might bully the rest. These parallels are striking.

It may be concluded that there is a strong possibility that the essential parts of social behavior and organization discovered in this small flock of domestic sheep may reappear in any flock reared with a minimum of interference, a fairly large range and small numbers. The study also gives interesting suggestions regarding the analysis of social organization in mountain sheep and in other ruminants with similar elements of social behavior.

W. C. Allee (1) has collected many lines of evidence which show that social behavior usually produces a result which is beneficial to the group. In particular he has stressed the idea of unconscious coöperation among lower animals, which may form aggregations in which they find protection from adverse physical or chemical conditions. Observations on the sheep agree with these two conceptions. However, the sheep being animals whose social behavior is highly developed, it is found that the primitive unconscious coöperation is confined to the type of behavior which has been classified as shelter-seeking; most of the social behavior of sheep is obviously on a higher level and is directly coöperative in its effects. Instances in which individuals injured each other were decidedly rare in the flock studied.

## HUMAN APPLICATIONS

Judging from the experience of the older biologists, who sometimes pontificated where sociologists feared to express an opinion, it is well to be over-conservative in discussing applications to human affairs. On the other hand, since the present work was done because it might be a possible indirect contribution to human sociology, and since in the absence of direction extremely loose generalizations are likely to be made from such material, an attempt will be made to point out and precisely limit the applications which exist.

Besides avoiding the obvious error of generalizing from specific data, the following rules should be observed in applying biosociological data to human problems: (*a*) it must always be remembered that human social organization is on an entirely different level because of the presence of language, and (*b*) a precise comparison between human behavior and that of the animal involved must be made; results will be the same only if the same causal factors are present.

Given these rules, the domestic sheep should provide good experimental material for certain classes of human problems:

(1) Anything involving allelomimetic behavior, particularly the co-ordinated movements of groups. This type of activity appears to be important to both sheep and people. The results of this paper indicate that early training is a large factor in its development among sheep, and human beings are trained from their earliest years to conform and do what the others do. Within these limitations there is a close parallel between sheep and human behavior of this type.

(2) Certain problems regarding relationship and family life. The organization of the sheep flock can be analyzed in part in terms of relationship, and certain interesting observations have already been pointed out, especially the connection between relationship and leadership, and the nervousness which appeared when the behavior of the lamb's mother deviated from that of the flock. However,

sheep relationships have a purely biological basis and are associated with no verbal rules. Besides this, there is probably no human family system in which the father relationship is entirely missing. In sheep, even the lamb-ewe relationship is relatively impermanent.

(3) Leadership of a group which has allelomimetic behavior. A great many human problems of leadership involve trying to get a group to act together in a new direction. In so far as allelomimetic behavior is similar in sheep and man the sheep should provide good experimental material, but the situation can never be exactly the same because of the absence of language in the sheep.

Probably the most important implication of these studies arises in connection with leadership. One of our basic social beliefs appears to be that leadership is the result of superior ability. It is a thought-provoking fact that in the flock of sheep studied allelomimetic prostasia appeared to be in a large part the result of training the young to follow. The "ablest" leader of the flock had no influence on the young orphan ewe which had not been trained to follow. It is also interesting that the method of training a lamb to follow is essentially one of giving a reward.

An even more fundamental belief appears to be that the ability to lead must be demonstrated by some sort of competition or fighting. As the small child puts it, "The best fighter is the leader." It was probably because of this idea that the peck-order studies of Schjelderup-Ebbe (19) commanded such attention, especially since they involved factors that were obviously important in human leadership, such as age and home territory.

The observations described above indicate that several different sorts of leadership can exist in the sheep besides that based on fighting, which appeared to have only minor significance under the conditions described. Leadership of the flock went to an elderly ewe, inferior in strength and fighting ability to almost any ram, and often inferior to the younger ewes. This position was achieved mainly by the care and feeding of her descendents without, as far as the observer can tell, any instance of violence toward her offspring.

It would be tempting to state that this and other forms of leadership exist (or could exist) among human beings. However, the data justify only the suggestion that it might be well to catalog and classify the types of leadership in human beings, among which might be found some resembling those in the sheep. One might go so far as to say that with so many sorts of prostasia present in the sheep it is unlikely that only one form would be found in man. The work of Yerkes (23) on sexual prostasia in apes supports this idea.

## SUMMARY AND CONCLUSIONS

1. This study represents an attempt to analyze social organization and leadership among sheep upon the basis of social behavior.

2. Observations and experiments were made chiefly on the descendents of two grade ewes over a period of four years, under conditions permitting a minimum of human care and interference.

3. It was found that the social behavior of these sheep could be naturally classified into eight types: investigation, eating, shelter-seeking, fighting, allelomimetic (mutual imitation), epimeletic (care or attention), et-epimeletic (calling or signalling for epimeletic behavior) and sexual.

4. In the development of an individual, et-epimeletic behavior at first takes the place of some forms of adult adjustment, especially food-getting and allelomimetic behavior. Play includes immature forms of sexual, fighting and allelomimetic behavior. Epimeletic behavior appears only in the ewes after they gave birth to lambs.

5. Development of two orphan lambs indicated that early training played an important part in the development of both allelomimetic behavior and leadership.

6. The behavior of the flock followed a fairly regular daily round and consisted almost entirely of the allelomimetic wandering, feeding and bedding down of the flock. In cold weather the activity was chiefly diurnal; in hot weather nocturnal.

7. The seasonal round of behavior could be divided into three fairly definite periods: (*a*) from lambing through weaning, marked by epimeletic behavior of ewes and et-epimeletic behavior and nursing of lambs, (*b*) the breeding season, marked by sexual behavior between ewes and rams and mild fighting between the latter, and (*c*) the winter season, between breeding and lambing, the prominent type of behavior being allelomimetic.

8. All types of social behavior showed seasonal variation and five of these were definitely present in some seasons and absent in others. Two of the remaining three, the exception being investigation, show definite seasonal starting and stopping points in other animals. It was concluded that the classification of social behavior has a natural basis.

9. Six spontaneously formed groups were observed: (1) ewes only, showing allelomimetic behavior, (2) lambs only, with allelomimetic behavior, (3) rams only, showing a combination of allelomimetic and homosexual behavior, (4) ewe and ram or rams, showing chiefly sexual behavior, (5) ewe and lamb, with a combination of epimeletic, et-epimeletic and nursing behavior, and (6) ewes, rams and lambs, showing allelomimetic behavior with some sexual behavior on the part of rams.

10. It is concluded that all forms of social behavior except fighting have some cohesive effect, but that allelomimetic behavior is most important among sheep.

11. It is concluded that spontaneous group formation is a result of social behavior.

12. Four main types of relationships were found: between lambs and their mothers, between lambs born in the same year, between younger and older sheep, and between ewes and rams.

13. The lamb-ewe relationship was most important, both in the formation of groups and as a cause of social leadership.

14. A symbolic scheme for representing important relationships in the flock is presented.

15. Prostasia (social control) was observed in connection with the following combinations of behavior: (*a*) et-epimeletic ⟶ epimeletic, (*b*) epimeletic ⟶ nursing, allelomimetic, (*c*) allelomimetic, (*d*) sexual ⟷ sexual, (*e*) fighting ⟶ fighting, moving away or inhibition.

16. It was concluded that unequal allelomimetic prostasia between mother and lamb is most important, resulting in the leadership of the flock in most cases by the oldest ewe. This type of prostasia apparently develops from type (*b*) above.

17. Dominance (prostasia based on force or fighting) was relatively unimportant in this flock.

18. Tests of allelomimetic prostasia indicated that allelomimetic prostasia could be accounted for in part by the conditioning of young lambs to follow their mothers, their generalizing to follow older sheep, and the tendency for this response to disappear in older sheep. Experience with the physical environment and generalization from this is probably a second factor, and the tendency of rams to follow ewes a third.

19. Observations contained in this paper agree with scattered accounts of sheep behavior published by other authors.

20. Accounts of the behavior of the bighorn sheep indicate that the social behavior of this wild species is very similar to that of the domestic sheep, the main differences being increased vigor, the tendency to migrate, and the complete separation of ram and lamb-ewe herds outside the breeding season.

21. It is concluded that the sheep may be very useful in the experimental solution of human problems involving relationship, allelomimetic behavior, and a certain kind of leadership.

22. Applications to human affairs may be made provided (*a*) they are based on exact comparison with human behavior and (*b*) due allowance is made for the effect of language.

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